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(54) Name of invention Sensing Device for Temperature of Cooling Water in Internal Combustion Engine

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Specification

1. Title

Sensing Device for Temperature of Cooling Water in Internal Combustion Engine

2. Claim

In a sensing device for temperature of cooling water in internal combustion engine that provides a water temperature sensor in an engine coolant channel and that senses water temperature based on output voltage thereof, the sensing device for temperature of cooling water in internal combustion engine comprising:

means of detecting abnormal water temperature sensor that compares output voltage of the water temperature sensor with predetermined upper and lower limits, and detects abnormality when the output voltage is out of the predetermined limits;

means of clocking a duration of rotation of the engine from its startup, when abnormality of the water temperature sensor is detected; and

means of setting pseudo water temperature that increases a predetermined reference value by a predetermined ratio that corresponds to the duration of the engine rotation and sets pseudo water temperature.

3. Detailed Description of the Invention

<Industrial Applicability>

The invention relates to a sensing device for cooling water temperature of an internal combustion engine, and more specifically, to the failsafe technology in case of abnormality of the water temperature sensor.

<Description of the Related Art>

In the prior art, in an electronically controlled fuel injector, a thermistor-type water temperature sensor was used to sense temperature of cooling water, wherein water temperature was corrected when an operation of fuel oil consumption was performed. Correction of water temperature at startup and during warm-up is quite important for improvement of operability.

Therefore, in case of abnormality of a water temperature sensor, it is

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important that abnormal condition be promptly detected and failsafe operation be conducted.

To this end, conventionally, output voltage of the water temperature sensor was compared with predetermined upper and lower limits. For instance, when the voltage was out of the predetermined limits, the water temperature sensor considers abnormal. Then, the method of replacing it with predetermined fixed water temperatures was adopted (Refer to Kokai (Japan unexamined patent publication) No.Sho-59-107227).

<Problems to be resolved by the invention>
In the conventional failsafe operation, however, not only startability of a cold engine worsened when temperature was replaced with fixed temperature, but also the engine went out of order during warm-up following startup.

Hence, in view of the above-mentioned conventional problems, the objective of the invention is to ensure performance in practical operation by making more reliable pseudo-water temperature in the case of abnormality of the water temperature sensor.

<Means of Solving the Problem>
Hence, as shown in Fig. 1, the invention provides the construction wherein there are provided a means of detecting abnormal water temperature sensor that can detect abnormality when output voltage of the water temperature sensor is compared with predetermined upper/lower limits and found to be out of predetermined limits; a means of clocking that clocks a duration of rotation of an engine from its startup, when abnormality of the water temperature sensor is detected; and a means of setting pseudo water temperature by increasing predetermined reference values by a predetermined ratio that corresponds to the duration of the engine rotation.

<Operation of the Invention>
In the above construction, when the means of detecting abnormal water temperature sensor detects abnormal condition of the water sensor, the

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means of clocking clocks a duration of rotation of the engine from its start. Usually, with the duration of rotation of the engine, water temperature rises. Thus, the means of setting pseudo water temperature sets pseudo water temperature by increasing a predetermined reference value by a predetermined ratio that corresponds to the duration of rotation of the engine. This could allow pseudo water temperature that almost corresponds to actual water temperature to be obtained.

<Detailed description of the preferred embodiments>
In the following, one embodiment of the invention is described.

Now with reference to Fig. 2, supply voltage Vcc is applied to a water temperature sensor 1 comprised of a thermistor, via resistance 2. Then, terminal voltage of the thermistor based on a resistance value of the thermistor that varies with changing water temperatures is picked out via a smoothing circuit 3. The voltage Us is then A/D converted by an A/D converter 4 and read into a microcomputer 5.

In the microcomputer 5, according to a program shown in the flow chart of Fig. 3, an operation is performed, water temperature is detected, abnormality is determined, and pseudo water temperature for failsafe operation is set at each predetermined time.

In the microcomputer 5, a pulse signal in sync with rotation of the engine is entered from a crank angle sensor 6.

In the following, the operation according to the flow chart of Fig. 3 is described.

In Step 1 (designated as S1 in the figure, the same applies herein after), output voltage Us of the water temperature sensor 1 is A/D converted and read.

Then, in step 2, the read output voltage Us is compared with predetermined upper and lower limits MAX and MIN to determine whether there is any abnormal condition (See Fig. 4). If the voltage is within the

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predetermined limits, it is considered normal. Then, proceed to step 3 wherein water temperature Tw is derived from the output voltage Us and based on it, various controls are executed.

If it is determined in step 2 that the output voltage is out of the predetermined limits, the water temperature sensor is considered abnormal. Then, proceed to step 4 onward to conduct failsafe operation. Therefore, the step 2 corresponds to the means of detecting abnormal water temperature sensor.

In step 4, it is determined whether or not the power supply is turned ON.

When the power supply is OFF, proceed to step 5 wherein an increment value $\triangle$Tw of pseudo water temperature is set to 0.

When the power supply is ON, proceed to step 6 wherein it is determined if the engine is rotating depending on whether there is output of a pulse signal from the crank angle sensor 6, for instance.

If the engine is rotating, proceed to step 7 wherein the timer TM1 is to be counted up. Then, move to step 8 wherein it is judged whether a clocked value of the timer has reached a predetermined value. Only if it has reached, move to step 9 and clear the timer TM1. Then, in step 10, increase the increment value $\triangle$ Tw of the pseudo water temperature by 1. Next, proceed to step 11, add the increment value $\triangle$Tw to a reference value Two (equivalent to 0 to 20℃), and set the pseudo water temperature Tw'.

Thus, steps 4, 6, and 7 correspond to the clocking means that clocks a duration of engine rotation from its start, while steps 8 to 11 correspond to the means of setting pseudo water temperature wherein pseudo water temperature is set by increasing a predetermined reference value by a predetermined ratio in accordance with the duration of the engine rotation.

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In this embodiment, arrangement is made whereby a duration of engine rotation after the power is turned ON is to be clocked. Alternatively, however, the arrangement may also be made so that a duration of the engine rotation is measured after Start switch is turned ON → OFF.

In a next step 12, the pseudo temperature Tw' is compared with a predetermined upper limit (equivalent to 80℃), and when it exceeds the upper limit, it is fixed to the pseudo water temperature Tw' in step 13.

Thus, as illustrated in Fig. 5, the pseudo water temperature Tw' is kept at the standard value (0 to 20℃) before the engine starts rotating after the power supply is turned ON. Then after the engine starts, the pseudo water temperature Tw' rises over time, and when it reaches the upper limit (80℃), it will be fixed.

In addition, while the power is ON and rotation of the engine is stopped, depending on the judgment in step 6, move to step 14 and count up the timer TM2. Then, proceed to step 15 wherein it is determined whether a clocked value of the timer TM2 has reached a predetermined value. If and only if it has, clear the timer TM2 in step 16 and decrease the increment value $\triangle$Tw of the pseudo water temperature in step 17. Then, move to step 18, add the increment value $\triangle$Tw to the predetermined reference value TW_0 and set the pseudo water temperature Tw'.

In the following step 19, the pseudo water temperature Tw' is compared with a predetermined lower value (reference value). When it falls below the lower limit, fix the pseudo water temperature Tw' to the lower limit in step 20.

Thus, when the engine stops its rotation, the pseudo water temperature Tw' falls as the stop time elapses, and is fixed when it reaches the reference value (0 to 20℃).

As such, when the pseudo water temperature is set, it is replaced with the water temperature Tw in step 21, based on which various controls

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are executed.

<Effects of the Invention>
As we described in the above, this invention would allow us to obtain pseudo water temperature that almost corresponds to actual water temperature, even in the case of a failure of a water temperature sensor, thereby ensuring practical operability.

4. Brief Description of the drawings

Fig. 1 is a functional block diagram showing construction of this invention.
Fig. 2 is a system view illustrating one embodiment of this invention.
Fig. 3 is a flow chart showing what controls are to be executed.
Fig.4 is a view showing the range of abnormality judgment of the water temperature sensor.
Fig. 5 illustrates how pseudo water temperature is set.

1. Water Temperature Sensor 5. Microcomputer

Fig. 1
1) Water Temperature Sensor
2) Means of Detecting Abnormal Water Temperature Sensor
3) Duration in which Engine is Rotating
4) Clocking Means
5) Means of Setting Pseudo Water Temperature

Fig. 2
6) Microcomputer

Fig. 3
1) A/D convert sensor output Us
2) Is it within the predetermined limits?
3) Is the power turned ON?
4) Is the engine rotating?
5) Timer TM1 counted up.

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6/10) Predetermined time?

7) Clear the timer TM1

8) Tw' - Upper Limit

9) Timer TM2 counted up

11) Clear Timer TM2

12) Tw': Lower Limit

12') Tw'←Lower Limit

Fig. 4

1) Range in which Us can be taken

Fig. 5

2) Pseudo Water Temperature

3) Upper Limit

4) Reference Value

5) Power is turned ON

6) Engine is rotating

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Application Number: Sho-63-149019

Application Date: November, 17, 1988

Creator: Naomi Tomizawa

Applicant: JEOL,Ltd.

Title of the Invention

A cooling water temperature detecting unit for internal combustion engine

Claim:

A cooling water temperature detecting unit for internal combustion engine including a water temperature sensor facing an engine cooling water passage and detecting a water temperature based on an output voltage from the sensor, the detecting unit comprising: water-temperature-sensor abnormality detecting means operative to compare the output voltage from the water temperature sensor with a predetermined upper limit value and with a predetermined lower limit value so as to detect abnormality when the output voltage is out of a predetermined voltage range; timer means for counting time from engine start

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to give a duration of engine rotation when the water-temperature-sensor abnormality is detected; and dummy water temperature setting means for setting a dummy water temperature by increasing a predetermined reference value at a given rate and according to the duration of engine rotation.

Brief Description of the Drawings

Fig.1 is a function block diagram showing an arrangement of the present device; Fig.2 is a system diagram showing one embodiment of the device; Fig.3 is a flow chart showing the contents of control; Fig.4 is a diagram showing ranges of abnormality to be judged by a water temperature sensor; and Fig.5 is a graphical representation of how to set a dummy water temperature.

1: WATER TEMPERATURE SENSOR, 5: MICRO COMPUTER

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Fig.1

水温センサ; WATER TEMPERATURE SENSOR

水温センサ異常検出手段: WATER-TEMPERATURE-SENSOR ABNORMALITY DETECTING MEANS

機関回転継続時間: DURATION OF ENGINE ROTATION

計時手段: TIMER MEANS

擬似水温設定手段: DUMMY WATER TEMPERATURE SETTING MEANS

Fig.2

5: MICRO COMPUTER

FiG.4

Usの取りうる範囲: EFFECTIVE RANGE OF Us VALUE

FiG.5

擬似水温: DUMMY WATER TEMPERATURE

上限値: UPPER LIMIT

基準値: REFERENCE VALUE

電源: POWER SOURCE

機関回転中: ENGINE IN ROTATION

FiG.3

S1: SENSOR OUTPUT Us

S2: WITHIN PREDETERMINED RANGE?

S4: POWER ON?

S5: IN ROTATION?

S7: TIMER TM1 UP

S8: PREDETERMINED TIME ELAPSED?

S9: CLEAR TIMER TM1

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S12: Tw': UPPER LIMIT

S13: Tw'← UPPER LIMIT

S14: TIMER TM2 UP

S15: PREDETERMINED TIME ELAPSED?

S16: CLEAR TIMER TM2

S19: Tw': LOWER LIMIT

S20: Tw'← LOWER LIMIT

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JP-U-61-099650 teaches a self-diagnosis and fail-safe apparatus for an engine coolant temperature detecting circuit. Each time coolant temperature is detected, a change of temperature in a unit time is calculated and compared with a reference value. If the calculated temperature change is abnormal, abnormality is indicated, and the previously detected temperature is used for various controls.

JP-U-02-050043 teaches a coolant temperature sensor diagnosis apparatus. When a predetermined time passes after an engine is started, a coolant temperature is detected and compared with a reference temperature, which is predetermined as a lowest limit which the coolant temperature should attain. If the detected temperature is lower than the reference temperature, a coolant temperature sensor is determined as abnormal.

JP-U-02-072343 teaches a coolant temperature detecting apparatus. When an engine coolant temperature is detected as being abnormal, the coolant temperature is estimated as increasing based on the time of operation of the engine after being started, and used in place of the detected temperature.

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⑫公開実用新案公報（U）　平2−72343

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⑬公開　平成2年(1990)6月1日

審査請求　未請求　請求項の数 1　（全　頁）

⑭考案の名称　内燃機関の冷却水温検出装置

⑳実　願　昭63−149019

㉒出　願　昭63(1988)11月17日

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明　細　書

1．考案の名称

内燃機関の冷却水温検出装置

2．実用新案登録請求の範囲

機関冷却水通路に水温センサを臨ませ、その出力電圧に基づいて水温を検出する内燃機関の冷却水温検出装置において、水温センサの出力電圧を所定の上限値及び下限値と比較して所定の範囲外のときに異常を検出する水温センサ異常検出手段と、水温センサの異常検出時に、機関の始動からの機関回転の継続時間を計測する計時手段と、この機関回転の継続時間に合わせて所定の基準値を所定の割合で増大させて疑似水温を設定する疑似水温設定手段とを設けたことを特徴とする内燃機関の冷却水温検出装置。

3．考案の詳細な説明

〈産業上の利用分野〉

本考案は、内燃機関の冷却水温検出装置に関し、特に水温センサの異常時のフェイルセーフ技術に関する。

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実開2- 72343

〈従来の技術〉

従来より、内燃機関の電子制御燃料噴射装置においては、冷却水温をサーミスタ式の水温センサにより検出し、燃料噴射量の演算に際して水温補正を行っており、特に始動時及び暖機中の水温補正は運転性の向上にとって極めて重要である。

従って、水温センサの異常時にはこれを速やかに検出してフェイルセーフ処理を行う必要がある。

このため、従来は、水温センサの出力電圧を所定の上限値及び下限値と比較して、所定の範囲外となったときなどに、水温センサの異常とみなし、このとき、所定の固定水温に読み替える方法を採用していた（特開昭５９－１０７２２７号公報参照）。

〈考案が解決しようとする課題〉

しかしながら、このような従来のフェイルセーフ処理では、固定水温に読み替えた時、冷機始動性が悪化したり、始動後の暖機中にエンジン不調となる場合があるという問題点があった。

本考案は、このような従来の問題点に鑑み、水

温センサの異常時の疑似水温をより確かなものとして、実用運転性能の確保を図ることができるようにすることを目的とする。

〈課題を解決するための手段〉

このため、本考案は、第1図に示すように、水温センサの出力電圧を所定の上限値及び下限値と比較して所定の範囲外のときに異常を検出する水温センサ異常検出手段と、水温センサの異常検出時に、機関の始動からの機関回転の継続時間を計測する計時手段と、この機関回転の継続時間に合わせて所定の基準値を所定の割合で増大させて疑似水温を設定する疑似水温設定手段とを設ける構成とする。

〈作用〉

上記の構成においては、水温センサ異常検出手段により水温センサの異常が検出されている場合は、計時手段により、機関の始動からの機関回転の継続時間を計測する。通常、この機関回転の継続時間に伴って水温は上昇する。従って、疑似水温設定手段は、この機関回転の継続時間に合わせ

て所定の基準値を所定の割合で増大させて疑似水温を設定する。これにより、実際の水温にほぼ対応した疑似水温が得られる。

〈実施例〉

以下に本考案の一実施例を説明する。

第２図を参照し、サーミスタからなる水温センサ１に、電源電圧Ｖccを抵抗２を介して印加し、水温の変化に伴うサーミスタの抵抗値の変化に基づくサーミスタの端子電圧を平滑回路３を介して取出し、その電圧ＵｓをＡ／Ｄ変換器４によりＡ／Ｄ変換して、マイクロコンピュータ５に読込む。

マイクロコンピュータ５では、第３図のフローチャートに示すプログラムに従って所定時間毎に演算処理し、水温の検出，異常判定及びフェイルセーフ用疑似水温の設定等を行う。

尚、マイクロコンピュータ５には、クランク角センサ６からの機関回転に同期したパルス信号等が入力されている。

第３図のフローチャートに従って演算処理の様子を説明する。

ステップ１（図にはＳ１と記してある。以下同様）では、水温センサ１の出力電圧ＵｓをＡ／Ｄ変換して読込む。

次に、ステップ２では、読込んだ出力電圧Ｕｓを所定の上限値ＭＡＸ及び下限値ＭＩＮと比較して、異常の有無を判定する（第４図参照）。ここで、所定の範囲内であれば、正常とみなし、ステップ３へ進んで、出力電圧Ｕｓから水温Ｔｗを知り、これに基づいて各種制御を行わせる。

ステップ２での判定で所定の範囲外の場合は、水温センサ１の異常とみなし、フェイルセーフ処理のため、ステップ４以降へ進む。従って、ステップ２の部分が水温センサ異常検出手段に相当する。

ステップ４では、電源がＯＮ状態であるか否かを判定する。

電源がＯＦＦ状態の場合は、ステップ５に進んで疑似水温の増加値ΔＴｗを０にする。

電源がＯＮ状態の場合は、ステップ６に進んで例えばクランク角センサ６からのパルス信号の出

力の有無より機関回転中か否かを判定する。

機関回転中の場合は、ステップ7に進んでタイマＴＭ1をカウントアップする。次にステップ8に進んでタイマの計時値が所定値に達したか否かを判定し、達している場合のみ、ステップ9でタイマＴＭ1をクリアした後、ステップ10で疑似水温の増加値ΔＴｗを1アップする。次にステップ11に進んで所定の基準値Ｔｗ。（0～20℃相当）に増加値ΔＴｗを加算して、疑似水温Ｔｗ'を設定する。

従って、ステップ4，6，7の部分が、水温センサの異常検出時に、機関の始動からの機関回転の継続時間を計測する計時手段に相当し、ステップ8～11の部分が、機関回転の継続時間に合わせて所定の基準値を所定の割合で増大させて疑似水温を設定する疑似水温設定手段に相当する。

尚、本実施例では、電源ＯＮ後の機関回転の継続時間を計測するようにしているが、スタートスイッチのＯＮ→ＯＦＦ後の機関回転の継続時間を計測するようにしてもよい。

次のステップ12では疑似水温Ｔｗ'を所定の上限値（80℃相当）と比較し、上限値を超えた場合は、ステップ13で疑似水温Ｔｗ'を上限値に固定する。

従って、第５図に示すように、電源ＯＮ後、機関回転開始前までは疑似水温Ｔｗ'は基準値（０～20℃）に保たれ、始動後は時間経過と共に疑似水温Ｔｗ'が上昇し、上限値（80℃）に達すると、それに固定される。

また、電源がＯＮ状態で、かつ機関回転停止中は、ステップ６の判定で、ステップ14に進んでタイマＴＭ２をカウントアップする。次にステップ15に進んでタイマＴＭ２の計時値が所定値に達したか否かを判定し、達している場合のみ、ステップ16でタイマＴＭ２をクリアした後、ステップ17で疑似水温の増加値ΔＴｗを１ダウンする。次にステップ18に進んで所定の基準値Ｔｗ。に増加値ΔＴｗを加算して、疑似水温Ｔｗ'を設定する。

次のステップ19では疑似水温Ｔｗ'を所定の下限値（基準値）と比較し、下限値を下回った場合

は、ステップ20で疑似水温Ｔｗ'を下限値に固定する。

従って、機関回転が停止された場合は、停止時間の経過と共に、疑似水温Ｔｗ'が低下し、基準値（０～20℃）に達すると、それに固定される。

このようにして疑似水温Ｔｗ'が設定されると、ステップ21で水温Ｔｗとして読み替えられ、これに基づいて各種制御が行われる。

〈考案の効果〉

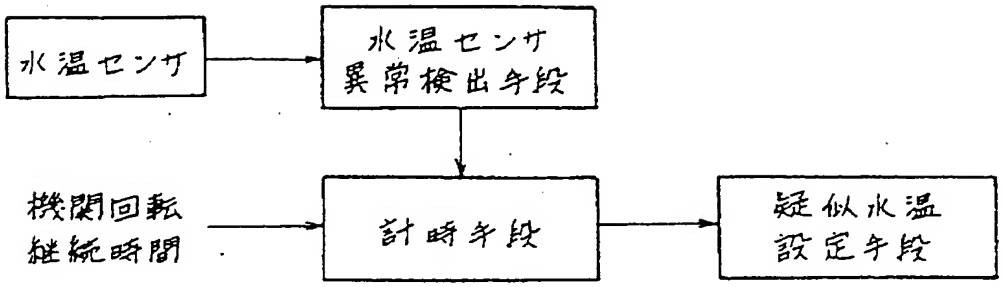
以上説明したように本考案によれば、水温センサの故障時にも、実際の水温にほぼ対応した疑似水温が得られ、実用運転性能を確保することができるという効果が得られる。

4．図面の簡単な説明

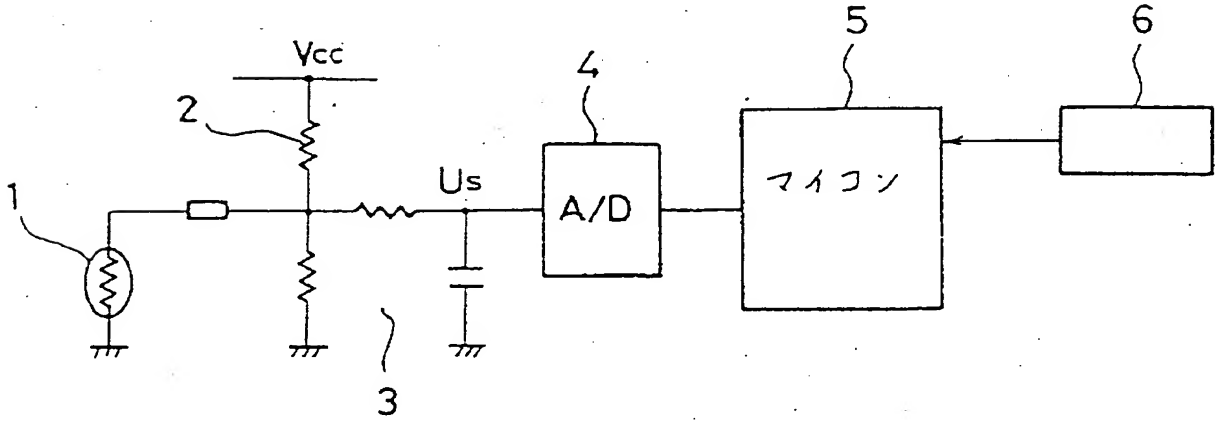
第１図は本考案の構成を示す機能ブロック図、第２図は本考案の一実施例を示すシステム図、第３図は制御内容を示すフローチャート、第４図は水温センサの異常判定の範囲を示す図、第５図は疑似水温の設定の様子を示す図である。

１…水温センサ　　５…マイクロコンピュータ

第 1 図



第 2 図



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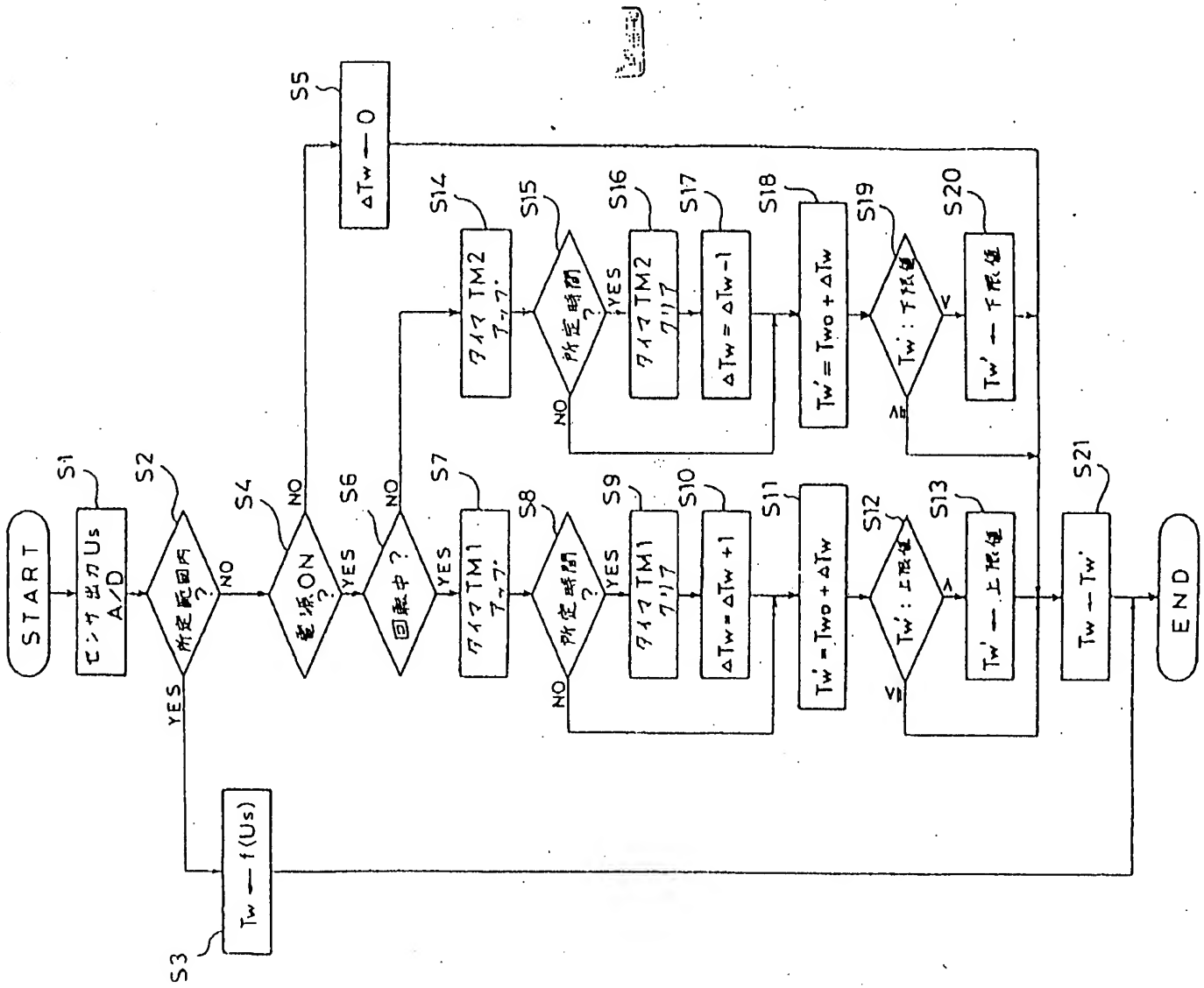

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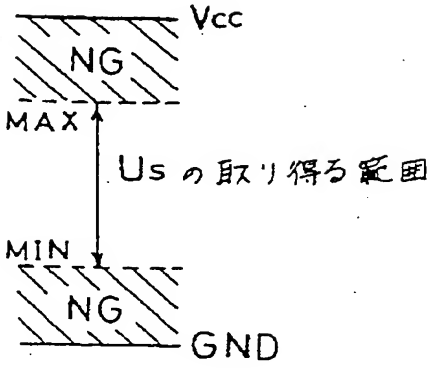

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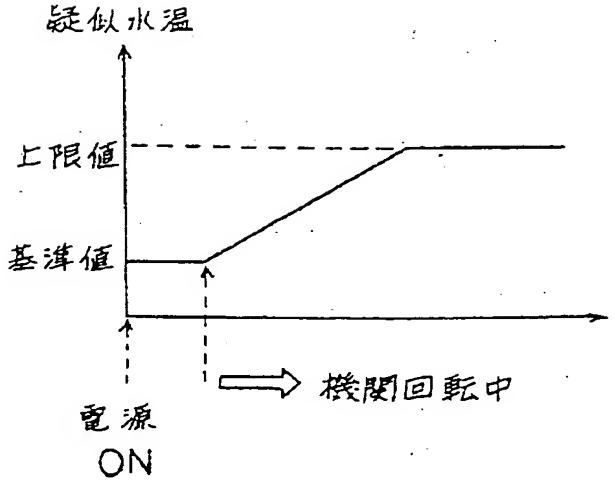

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